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U.S. DEPARTMENT OF THE INTERIOR – BUREAU OF LAND MANAGEMENT

HABITAT MANAGEMENT SERIES FOR UNIQUE OR ENDANGERED SPECIES

by Mark Zarn, Research Biologist
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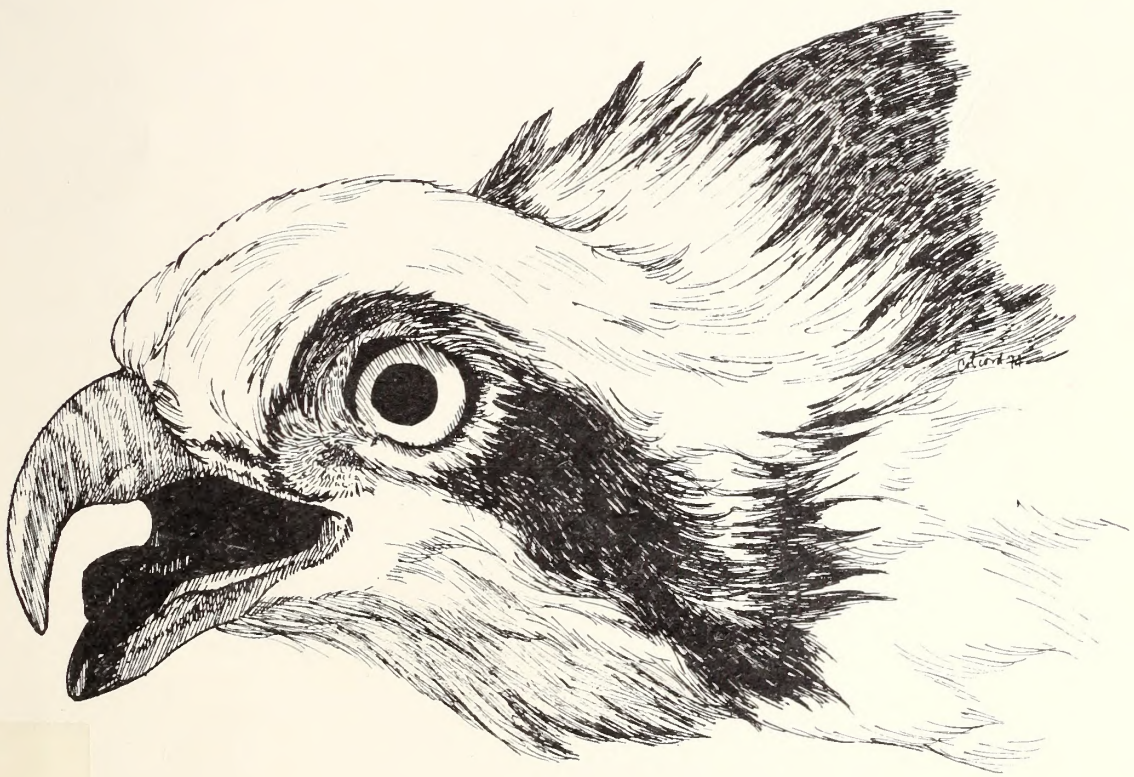
Report No. 12
Osprey
Pandion haliaetus carolinensis



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FOREWORD

This Technical Note series on wildlife is designed to provide a literature review and summary of current knowledge pertaining to endangered and other wildlife species occurring on public lands. We in the Bureau of Land Management have recognized the need for basic wildlife information in order to do an effective job in land-use planning. Sound planning must identify the negative aspects as well as the positive benefits of any proposed land management decision or program. It is our hope, too, that this series will also prove useful to others--be they land managers, students, researchers or interested citizens.

Curt Berklund

Director
Bureau of Land Management
Department of the Interior

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Introduction

The objective of this report is to provide BLM personnel with the latest and most up-to-date information on rare or endangered species occurring on the public domain. This will provide a tool for improved understanding of the interrelationships between the species and its environment and encourage an end product of enlightened land management which will fully consider the species' welfare in all management decisions.

Species Description

The osprey is the sole member of the family Pandionidae, a designation merited because of the species' unique morphological adaptations. The combination of sharp spines covering the lower surfaces of the feet and a reversible outer toe aids the osprey in securing its grip on slippery fish.

The distinctive plumage of the osprey distinguishes it from all other birds of prey. Adult coloration consists of dark brown upper parts and wing coverts with broad dark streaks on the sides of the head. White plumage covers the crown, neck, and underparts. The breast and crown are splotched with brown, particularly on the female. The light-colored tail exhibits fine dark bands and a broad terminal bar edged with white. The iris is yellow. The black, strongly curved claws are of equal length. The bill is dark; color of the legs and toes is bluish-gray.

A medium-large hawk, the osprey attains a body length of 53-65 centimeters. Females are larger than males, with an average wingspan of 163.0 (range 154.0 - 168.3) cm and average weight of about 1570 (range 1250 - 1900) gm. Male wingspan averages 159.0 (range 147.0 - 166.3) cm; male weight averages 1400 (range 1220 - 1600) gm.

Juveniles attain adult plumage by the time they reach eighteen months of age. Even juveniles of less than eighteen months strongly resemble adults. Buffy to white tips on all feathers of the dorsal surfaces, buffier ventral surfaces, more extensive white tipping of the tail, and more reddish irises comprise the major distinguishing features of juvenile ospreys.

Creamy-white down covers hatchling ospreys, with dark brown through the eyes and on anterior portions of the back. The head and a dorsal streak from nape to tail are sand-buff in color. The second natal down, appearing at ages two through four weeks, consists of smoke-brown down dorsally and creamy-white ventrally. The dorsal streak becomes white and the ventral surfaces become more whitish, tipped with brown.

Figure 1

The osprey, Pandion haliaetus carolinensis

Specimen courtesy of Colorado Division of Wildlife.

Owing to similarity in size and habits, the field observer may mistake a distant osprey for a bald eagle (Haliaetus leucocephalus). But the osprey's white ventral surfaces are quite distinctive, and when viewed from below the osprey exhibits dark wrist patches at the joint of its wings. In contrast to other hawks and eagles, the wings of the osprey are very long and narrow, and appear bowed or angled in flight. All other large raptors fly with wings straight. In addition ospreys are the only hawks which dive into water feet first (Bent, 1937; Gabrielson and Jewett, 1940; Jewett, Taylor, Shaw and Aldrich, 1953; Blake, 1953; Bailey and Niedrach, 1965; Reilly, 1968; Brown and Amadon, 1968; Ligon, 1961; Welty, 1962).

Distribution

The osprey enjoys a nearly cosmopolitan distribution, as extensive as that of any bird of prey. Five subspecies have been described but only one, Pandion haliaetus carolinensis, occurs in North America. (See Page 4, Figure 2.)

The northern limit of the breeding range of Pandion haliaetus carolinensis extends from northwestern Alaska, across central Yukon, northwest MacKenzie, and northern Manitoba and Ontario to central Quebec, southern Labrador and Newfoundland. In western North America scattered populations occur south along the Pacific coast through Baja California and also along the coast of the Gulf of California. Small breeding populations extend into the southwest states, but more significant inland concentrations occur in the states of Idaho (Johnson and Melquist, 1973), Montana (Koplin, D. S. MacCarter and D. L. MacCarter, 1971; D. L. MacCarter, 1972; D. S. MacCarter, 1972), Wyoming (Swenson and Eng, 1973), California (Garber, 1972; Kahl, 1972) and Oregon (Roberts, 1969, 1970).

According to the American Ornithologists' Union (1957), the winter range of this subspecies includes central California, southern Texas, southern Mississippi and Alabama, central Florida and the Bahamas south to Peru and Brazil. Koplin, however, believes that ospreys winter in Central America, and that observations of ospreys in Texas, Louisiana and similar areas before December are probably of migrants in transit to Central America. Birds in Baja California and Florida are probably residents, or between September and November or December, a mixture of residents and migrants (Koplin, personal communication). Occasionally individuals reach Chile, Argentina, Paraguay or the Galapagos Islands. Non-breeding individuals may remain in portions of the winter range throughout the summer (American Ornithologists' Union, 1957; Peters, 1964).

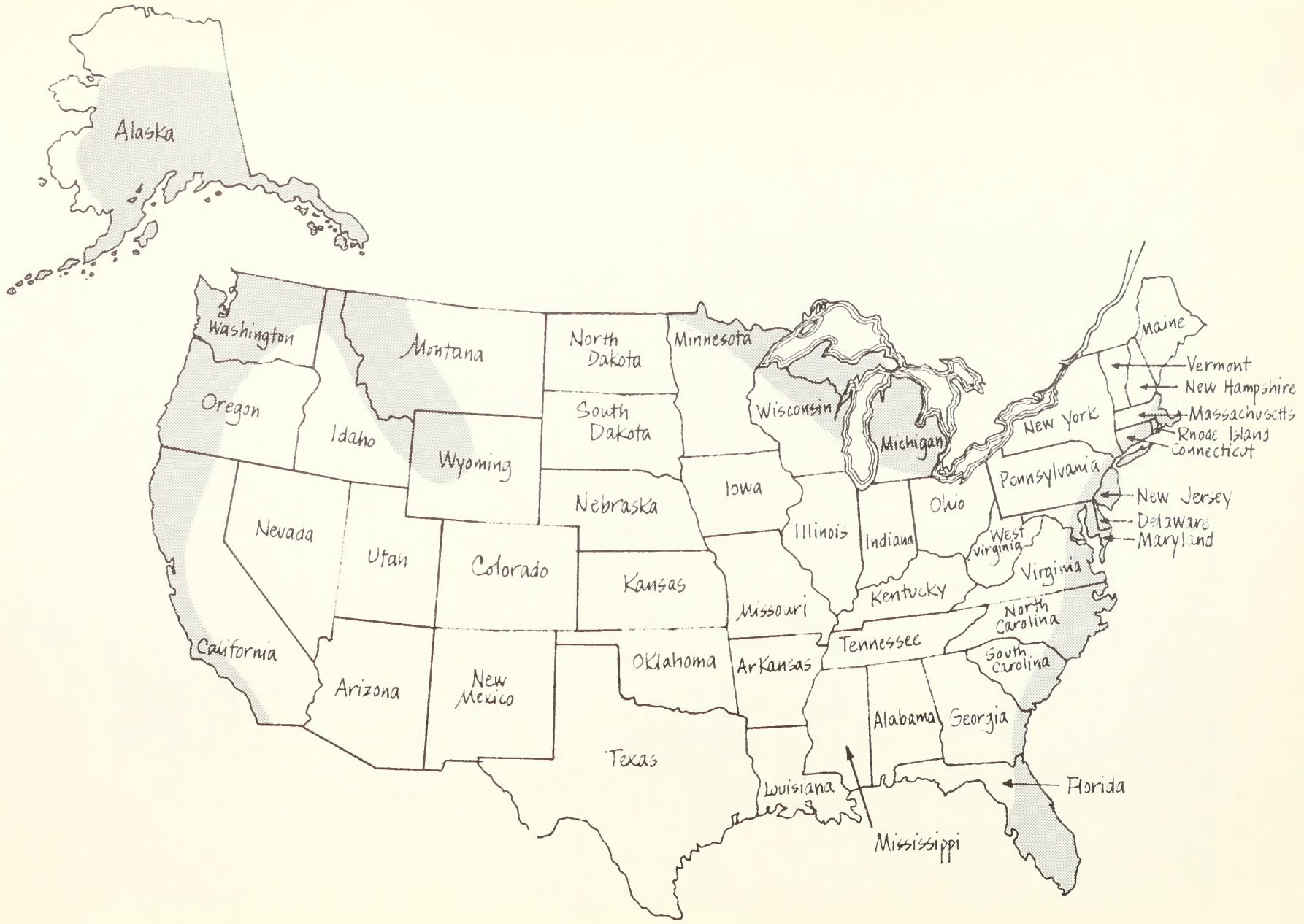

FIGURE 2. APPROXIMATE BREEDING DISTRIBUTION OF THE OSPREY IN THE UNITED STATES

Status and Population Trend

The status of the osprey in the United States is currently undetermined (Bureau of Sport Fisheries and Wildlife, 1973). Osprey populations in North America have been declining gradually since the latter part of the nineteenth century (Bent, 1937). Beginning in the late 1950's and early 1960's, observers noted drastic increases in the rates of decline in almost every breeding population of ospreys in the eastern United States. In Rhode Island the population declined fifty percent from 1954 to 1961 and dropped another forty percent between 1961 and 1962 (Emerson and Davenport, 1963; Dunstan, 1970). Osprey breeding pairs on the Connecticut shore of Long Island Sound numbered 200 in the early 1940's, but declined to only 24 pairs by 1963 (Ames and Mersereau, 1964). The long-term population decline has also increased significantly in New Jersey. Although production in 1963 compared favorably to that in 1939, many fewer pairs nested (Schmid, 1966). Osprey breeding populations in Michigan and Wisconsin have also exhibited major declines in both size and productivity (Postupalsky, 1968).

In other areas, notably Massachusetts (Fernandez and Fernandez, 1970) and portions of Maryland (Reese, 1968; Weimeyer, 1971), nesting populations remain fairly stable but undergo irregular fluctuations in productivity. To further confuse the issue, osprey populations on Chesapeake Bay, Maryland (Reese, 1970a) and in the Florida Everglades (Ogden, 1969) have remained stable and reproductively sound.

Research on osprey populations in the western United States began in 1966. Banding data for these populations is much less complete and long-term trends are thus impossible to detect. But if western ospreys are subject to the same mortality schedules demonstrated for ospreys in New York and New Jersey by Henny and Wight (1969), then certain western populations of this species are declining at a rate of two to five percent annually (Koplin, 1971; Koplin, MacCarter and MacCarter, 1971).

Life History

Although ospreys occasionally consume mammals, birds, reptiles, amphibians, and some invertebrates (Brown and Amadon, 1968; Grossman and Hamlet, 1964; Sindelar and Schluter, 1968; Wiley and Lohrer, 1973), they depend almost exclusively on fish for food.

Ospreys utilize a relatively small percentage of the fish fauna present, usually concentrating on only two or three species (D. S. MacCarter, 1972). At Flathead Lake, Montana, the

largescale sucker (Catostomus machrocheilus) constituted 59.4 percent of 241 observed osprey prey items in 1969 and 1970. Secondary prey were whitefish (Prosopium spp. and Coregonus sp.), representing 26.1 percent of the total. Salmon (Oncorhynchus spp.), yellow perch (Perca flavescens), peamouth chubs (Mylocheilus caurinus), cutthroat trout (Salmo clarki), black bullhead (Ictalurus melas) and sunfish (Lepomus gibbosus) constituted the remaining 14.5 percent (D. S. MacCarter, 1972).

Schroeder (1971) identified 17 of 18 fish delivered to an osprey nest at Black Lake, Idaho: 7 squawfish (Ptychocheilus oregonensis), 6 brown bullheads (Ictalurus nebulosus), 3 crappies (Pomoxis nigromaculatus) and 1 bluegill (Lepomis macrochirus).

Available prey species at Crane Prairie Reservoir in west-central Oregon include the tui chub (Siphateles bicolor), rainbow trout (Salmo gairdneri), brook trout (Salvelinus fontinalis), kokanee (Oncorhynchus nerka kennerlyi) and whitefish (Prosopium williamsoni) (Roberts, 1969). Tui chubs make up 87 percent of the number of fish and comprise 57 percent of the osprey's diet; six percent of prey items are whitefish, and the remaining 37 percent are salmonids (Koplin, 1971).

Garber (1971, 1972) documented a 48 percent occurrence of tui chubs in osprey nests at Eagle Lake in northeastern California. Thirty-four percent of the prey items were Eagle Lake trout (Salmo gairdneri aquilarium) and 18 percent were Tahoe suckers (Catostomus tahoensis). Prey in nests averaged 30.7 centimeters in length. At nearby Lake Almanor, diet consisted of brown bullheads, brown trout (Salmo trutta), silver salmon (Oncorhynchus kisutch), tui chubs, and suckers (Garber, 1971, 1972).

Ospreys studied in northwestern California foraged in three distinct localities. Those fishing in the southern portion of Humboldt Bay utilized 63 percent surfperch (Embiotocidae), one percent sculpins (Cottidae), 3 percent northern anchovies (Engraulis mordax), 2 percent Pacific herring (Clupea pallasi) and 2 percent silversides (Atherinidae) (Ueoka and Koplin, 1973). Hatchery-reared rainbow trout formed nearly the entire fish fauna of Freshwater Lagoon, furnishing food to ospreys nesting on Redwood Creek and Big Lagoon. The prey base of ospreys nesting on Usal Creek consisted of 98 percent surf smelt (Hypomesus pretiosus) and night smelt (Spirinchus starksi), and 2 percent surfperch (French, 1972).

While hunting, the osprey flies over the water at heights usually ranging from 15 to 30 meters. Upon sighting a fish it hovers momentarily with its legs trailing, or it may stoop to its prey

from flight. The osprey enters the water feet first, with wings extended above and behind. The force of its impact on the water varies with the depth of the intended prey. Usually it selects fish swimming just below the surface but occasionally may enter the water completely, capturing the prey in its talons. Then it resumes flight, shaking the water from its plumage, and returns to its perch or nest, carrying the fish head first in its talons (Bent, 1937; Brown and Amadon, 1968).

The osprey is a highly successful predator, capable of capturing two fish on a single dive (French 1972, Ueoka and Koplin, 1972). Lambert (1943) calculated an average predation efficiency in ospreys of 89 percent, but did not discuss the number of dives required before prey was captured. Ospreys at Flathead Lake, Montana, obtained prey in 83 percent of 158 efforts (D. L. MacCarter, 1972). Sixty-three percent were successful on the first dive. Ospreys at Eagle Lake, California were 80 percent successful in 25 efforts; 52 percent achieved success the first time (Garber, 1972). French (1972) found that ospreys fishing in surf in northern Mendocino County, California, were 67 percent successful on the first try with a total success of 86 percent. In 639 fishing efforts observed by Ueoka and Koplin (1973), ospreys in Humboldt Bay, California proved successful on 56 percent of their first dives, with an overall success rate of 82 percent.

While ospreys have little difficulty capturing fish, several factors influence the time they expend in every successful fishing effort. Abundance of prey is one such factor. Ospreys spent an average of 65 minutes away from the nest on fishing forays at oligotrophic (low in dissolved nutrients and primary productivity) Flathead Lake, Montana (D. S. MacCarter, 1972), while time away from the nest averaged only 32.5 minutes at mesotrophic (moderate dissolved nutrient levels and primary productivity) Eagle Lake, California (Garber, 1972). Ospreys in both locations maintained similar fishing success.

Lambert (1943) found that fishing success decreased as the summer progressed. High surface water temperatures may drive fish to greater depths in summer, decreasing their availability to surface predators such as ospreys. High numbers of inexperienced young birds may also bias summer success figures (Lambert, 1943; D. S. MacCarter, 1972). Ueoka and Koplin (1973) determined that tidal changes influenced fishing success in coastal osprey populations in California.

Visibility also affects fishing success of ospreys. Decreased light transmission through water on overcast or foggy days, and water agitation by wind action both serve to limit visibility and, hence, predatory success. These same factors may reduce fish supplies at the surface (MacCarter, 1972).

Ueoka and Koplin (1973) noted that foraging time seemed inversely related to food demand. Foraging time was lowest at the height of the brooding period, but increased again after the late fledging period, when food demand by the young decreased.

Adult ospreys begin to arrive on their nesting grounds from mid-March to early April--the exact date varying geographically--and continue to arrive for the next month (Kahl, 1971; Bent, 1937; Roberts, 1969; Bailey and Niedrach, 1965; Johnson and Melquist, 1973; D. L. MacCarter, 1972; French, 1972; Garber, 1972).

Pair bonding and nest site selection in some individuals or populations may carry over from year to year (Kahl, 1971; Johnson and Melquist, 1973). In contrast, French (1972) observed that ospreys in his study area showed little affinity for nest sites upon arrival. He found that some ospreys engaged in courtship activity and copulation at or near nests which they did not use for nesting. Others repaired nests and then failed to use them, or attempted nest construction before using an already existing nest.

Courtship behavior takes place after both members of a pair have arrived in the nesting area. The male displays with a spectacular series of upward climbs and dives at heights ranging from 150 to 300 meters above the nest. He hovers momentarily at the top of the climb and then dives with tail spread and wings closed, sometimes carrying a fish during this maneuver. The female watches from or near the nest. Both members of a pair may also fly above the nest, the male chasing the female. Ospreys copulate at the nest or on a nearby branch; the male treads on the female's back before cloacal apposition, flapping his wings for balance (Brown and Amadon, 1968; Johnson and Melquist, 1973; Levenson, personal communication). Copulation occurs within one day after a pair bond is formed and may continue over several weeks (Garber, 1972).

Nest construction and maintenance continue through most of April. Osprey use nests year after year; nests average 0.9 - 1.1 m in diameter and 0.3 - 0.6 m in depth (Brown and Amadon, 1968; Garber, 1972; Bent, 1937; Roberts, 1969). Although constructed mostly of sticks 2.5 - 5.0 cm in diameter and up to 0.5 m long (Kahl, 1972), nests may include a wide variety of other materials. The female positions most of the sticks in the nest. At onset of incubation a shallow cavity 2.5 - 6.4 cm in depth houses the clutch of eggs, but nestling activity gradually causes this depression to disappear. By fledging the nest has flattened to a nearly level platform (Garber, 1972).

The top of a tall dead snag surrounded by water provides the ideal nesting site for an osprey. In the absence of such a site ospreys will utilize live trees with dead crowns, tall stumps, pilings, and even telephone poles and other artificial structures in proximity to a body of water. If nesting sites are in short supply they may nest a mile or more from water if the food supply proves adequate (Koplin, 1971). Ospreys nest on rock pinnacles and cliffs in Yellowstone National Park, Wyoming (Bailey and Niedrach, 1965).

Mean height of nest trees in two studies in California exceeded 25 m (French, 1972; Garber, 1972). At Flathead Lake, Montana, height of nests ranged from 7.5 to over 39 m above ground (D. L. MacCarter, 1972). But some ospreys at Lake Coeur d'Alene, Idaho nested on pilings only about three meters above the surface of the water (Schroeder, 1971). Snags must be sufficiently sturdy to support the bulky osprey nest (Garber, 1972).

Factors other than nest site availability may explain an absence of nesting ospreys. French (1972) stated that onshore wind and fog prevented ospreys from nesting on coastal areas of northwestern California. Winds destroyed osprey nests and fog restricted feeding activity in these areas.

Egg laying takes place at the end of April or beginning of May, and may extend to early June. One to four, but usually three, eggs constitutes a clutch (Bent, 1937; Kahl, 1971; D. L. MacCarter, 1972; Garber, 1972; French, 1972; French and Koplin, 1972; Brown and Amadon, 1968). The eggs are smooth, elongate-ovate in shape and white with striking chocolate to red-brown and drab underlying markings. Size averages 61 x 45.6 mm (Bent, 1937; Brown and Amadon, 1968). The female deposits her eggs at intervals of one or two days, and begins incubation with the first egg. Early investigators stated that only the female incubated, but more recent observation by Garber and Koplin (1972) indicates that the male shares up to 30 percent of incubation duties, trading positions with the female about 6.4 times per day. After the first egg hatches males cease to aid in either incubation or brooding.

Ospreys in western North America may incubate eggs for longer periods than do eastern populations. Bent (1937) and Ames (1964) give incubation periods of 28 to 33 days for eastern birds. Studies at Eagle Lake, California, however, showed that incubation might extend to 43 days, and averaged 39.5 days in 1970 (Garber, 1970, 1972; Garber and Koplin, 1972). Incubation lasts about 38 days in northern Idaho (Johnson and Melquist, 1973). The male furnishes food to the female, who rarely leaves the vicinity of the nest during incubation and the first six weeks

of the eight-week brooding period (Bent, 1937; D. S. MacCarter, 1972; Ames, 1964; Kahl, 1971, 1972; Koplin, personal communication). The young begin to hatch during the last week in May and hatching continues through mid-June (Kahl, 1971; Garber and Koplin, 1972; Garber, 1972).

Adults cease to incubate unhatched eggs when the young attain the age of 6 to 10 days. But ospreys experiencing reproductive failure do not abandon the nest until 2 to 3 weeks after all young have hatched (Garber, 1970, 1972; Koplin et al., 1971; French, 1972). In some cases ospreys which have experienced nesting failure construct a "frustration nest" after abandoning their original nest. Ospreys do not attend frustration nests after they have constructed them (French, 1972; Kahl, 1971).

Young ospreys hatch at intervals, so that when hatching is completed the oldest is significantly larger than the youngest. Newly hatched ospreys are almost completely helpless and do little more than lie in the nest for the first two weeks, when they become stronger and can sit up. Bullying of the smallest may occur, and while the youngest juvenile is rarely killed outright it may succumb to starvation when food is scarce (Kahl, 1971, 1972; Bent, 1937; Brown and Amadon, 1968).

Male ospreys in northern Idaho make daily deliveries to the nest of 2 to 8 fish during brooding (Schroeder, 1972). Garber (1970) found that ospreys delivered an average of 8.8, 20.6, and 30.5 fish to nests containing, respectively, one, two, and three young. If the male is hungry he consumes the head and viscera before completing delivery of fish to the nest (D. S. MacCarter, 1972). The female feeds the young, usually one at a time, a rapid succession of small pieces of fish, alternately feeding the young and herself (Bent, 1937; Brown and Amadon, 1968; D. S. MacCarter, 1972; Johnson and Melquist, 1973). After the sixth week the female aids the male in procuring food for the young. She feeds the young less regularly but may offer them food occasionally even after they have left the nest (Brown and Amadon, 1968; Kahl, 1972).

Bent (1937) stated that ospreys fed their young at irregular intervals, feeding sessions dependent on the number and age of young and the size of the fish caught. D. S. MacCarter (1972) found that ospreys at Flathead Lake, Montana, fished during all daylight periods, but delivered the most fish (56 percent) to the nest before midday. They brought 15 percent of the fish to the nest at midday and 29 percent in the evening.

The female remains on the nest constantly for the first 30 days of the brooding period (Brown and Amadon, 1968). After this period her brooding behavior depends on weather conditions,

nest location and age of nestlings. During periods of wind, rain, or intensive sunlight, the female shelters the young with her wings (Bent, 1937; Brown and Amadon, 1968; Garber, 1972). Nickell (1967) watched a female that had been driven from her nest on a hot day. By the time she returned the young were panting from the heat. She flew to the surface of the water, dipped her breast feathers several times and, returning to the nest, sheltered the young with her wings, bringing her wet breast feathers in contact with the juveniles' bodies. By the time the young reach an age of seven weeks, adult ospreys have moved from the nest to nearby perches during daylight hours, but still brood the young at night (Garber, 1972; Bent, 1937).

Parent birds call a warning if an intruder enters the nesting area during the first two months of the brooding season. The young lie flat and very still on the floor of the nest, wings and necks extended, sometimes for over an hour, until the parent osprey sounds a note of assurance. The adults circle the intruder screaming loudly and may attack by diving and swooping, or at least threaten, enemies attempting to climb the nest (Kahl, 1971; Bent, 1937).

Young ospreys begin wing flapping exercises when five to six weeks old, and make their first flight at the age of about eight weeks (Kahl, 1971, 1972; Bent, 1937). In most western areas fledging begins in the third week of July and extends into August. Juveniles exceed adult weight at fledging (Garber, 1972; Johnson and Melquist, 1973).

Young ospreys continue to associate with parents and nest for about two months after fledging. They return to the nest to roost for the first week, and use it at less frequent intervals thereafter as a feeding platform (Brown and Amadon, 1968; Bent, 1937; D. L. MacCarter, 1972; D. S. MacCarter, 1972).

Little documentation exists for post-fledging activity of young ospreys. Meinertzhagen (1954) anthropomorphically described attempts by adult ospreys in Sweden to teach young to fish, and D. S. MacCarter (1972) stated that Flathead Lake ospreys appeared to teach their young to fish, but questioned the validity of his own conclusions. Bent (1937) and Craighead and Craighead (1939) both have stated that fishing behavior is innate and that ospreys do not teach their young to fish. This area of osprey life history needs more study.

Ospreys begin to migrate in mid- to late September, emigration continuing through October. Adults which have experienced nesting failure leave earlier than those which have reared young (Kahl, 1971; Garber, 1972; French, 1972; D. L. MacCarter, 1972). Ospreys move slowly toward their wintering grounds, usually

arriving in December (Koplin, personal communication). Immature birds may remain on the wintering grounds until their second or third year. Two-year-olds returning to breeding areas may build nests, but remain part of the non-breeding population until three years of age. These birds may also colonize new areas (Kahl, 1971; Johnson and Melquist, 1973).

Ospreys may be best known for their relationship with bald eagles (Haliaetus leucocephalus). At times bald eagles harass ospreys returning from successful fishing forays, causing them to drop their prey. The eagles recover the fish, sometimes in mid-air, and consume them. But eagles are often unsuccessful in their efforts, and this practice does not seem to adversely affect the osprey (Bent, 1937; Brown and Amadon, 1968; Garber, 1970, 1972). Magnificent frigate birds (Fregata magnificens) also parasitize ospreys in this way (Bent, 1937; Peck, 1967).

Several species of small birds including western kingbirds (Tyrannis verticalis), starlings (Sturnus vulgaris), tree swallows (Iridoprocne bicolor), house sparrows (Passer domesticus), and grackles (Quiscalus spp.) may nest in or beneath osprey nests, and also mob ospreys away from the nest. Ospreys generally ignore their activities (Bent, 1937; Garber, 1970, 1972).

Before the nesting season ospreys appear to be tolerant of larger species as well, but after they have laid eggs they interact more aggressively with crows (Corvus brachyrhynchos), ravens (Corvus corax), marsh hawks (Circus cyaneus), red-tailed hawks (Buteo jamaicensis), turkey vultures (Cathartes aura), great blue herons (Ardea herodias), and bald eagles near their nests (Garber, 1970, 1972; French and Koplin, 1972). Crows, ravens, magpies (Pica pica) and gulls may prey on osprey eggs (D. L. MacCarter, 1972; Kahl, 1971).

Competition between ospreys and Canada geese (Branta canadensis) for nesting sites also occurs. Since the geese arrive on the breeding grounds earlier, they may usurp nests traditionally used by ospreys. Ospreys occasionally drive geese from these nests (Melquist, 1974), but otherwise probably construct new ones (Roberts, 1969, 1970; Garber, 1970, 1972).

Nesting ospreys vocalize frequently and their calls are highly characteristic. The osprey has a weak voice for its size but when disturbed it may be heard for some distance. Usually the call is a short whistle with a rising inflection, "chewk, chewk, chewk." Alarmed males at the nest utter a frenzied, high-pitched "cheek, ch-cheek, chereek, chezeek, chezeek," while females emit a rapid "piu-piu-piu-piu." Ospreys deliver a greeting, "chirrup" when returning to a mate or young (Bent, 1937; Brown and Amadon, 1968).

Based on banding returns from a New York-New Jersey osprey population, Henny and Wight (1969) calculated that every breeding age female would have to produce an average of between 0.95 and 1.30 fledglings per year in order to offset mortality and maintain a stable population. Henny (verbal communication) feels that this recruitment standard is probably applicable to western osprey populations as well. Although osprey productivity in the western United States generally falls within the limits of Henny and Wight's standard, the status of western osprey populations remains uncertain (Koplin, 1971).

Table I presents the available osprey production data for the United States. This table is meant to give the reader an idea of temporal and spatial variations in osprey productivity, and it should be emphasized that these studies cannot necessarily be directly compared, owing to differences in methods employed to gather and analyze data. Several researchers have advanced techniques designed to minimize inaccuracies and methodological variations, so that data from osprey studies might be meaningfully compared. The first of these was Postupalsky (1968), whose recommended terminology as applicable to Table I appears below, with alternate terms in parentheses:

Occupied nest (occupied breeding territory, active nest, used nest): any nest at which at least one of the following activity patterns was observed during the breeding season:

a. Young were raised
b. Eggs were laid
c. One adult was observed sitting low in the nest, presumably incubating
d. Two adults on or near a nest regardless whether or not it had been repaired during the season under consideration
e. One adult and one bird in immature plumage at or near a nest, if mating behavior (display flights, nest repair, or copulation) was observed
f. A recently repaired nest with fresh sticks (with clean breaks) or fresh boughs on top, and/or droppings and/or molted feathers on its edges or underneath

All of the above observations indicate the known or inferred presence of one mated pair of birds associated with a nest.

Inactive nest (unoccupied or abandoned nesting territory or nesting site): is a nest or group of alternate nests at which none of the activity patterns diagnostic of an occupied nest were observed.

Table I. Osprey Reproductive Success in the United States

Location	Year	# Nests Occupied	# Nests Inactive	# Nests Productive	% Nest Success	# of Fledglings	# of Fledglings/ Productive Nest	# of Fledglings/ Occupied Nest
California [a]	1969 [1]	38	--	21	55	40	1.90	1.05
California [b]	1970 [2]	51	5	26	51	51	1.96	1.00
	1971 [2]	47	13	24	51	48	2.00	1.02
California [c]	1971 [3]	22	--	14	64	27	1.93	1.23
	1972 [3]	41	--	23	56	37	1.61	0.90
Florida [d]	1968 [4]	44	9	32	73	56	1.75	1.27
	1969 [4]	39	11	30	77	45	1.50	1.15
Idaho [e]	1970 [5]	37	18	20	54	32	1.60	0.86
	1971 [5]	60	17	26	43	46	1.77	0.77
	1972 [6]	179	45	99	55	192	1.94	1.25
	1973 [7]	204	73	134	65	289	2.16	1.42
Maryland	1966 [8]	77	--	47	61	79	1.68	1.03
	1967 [8]	83	--	48	58	80	1.67	0.96
	1968 [8]	93	--	52	56	89	1.71	0.96
	1969 [8]	94	--	51	54	90	1.76	0.96
	1970 [9]	102	--	55	54	22	0.40	0.22
	1971 [10]	105	--	53	50	91	1.72	0.87
Michigan	1965 [11]	50	3	11	22	18	1.64	0.36
	1966 [11]	50	4	9	18	15	1.67	0.30
	1967 [11]	62	2	17	27	30	1.76	0.48
	1968 [12]	69	--	25	36	32	1.28	0.46
	1969 [12]	67	--	23	34	33	1.43	0.49

Table I. Osprey Reproductive Success in the United States

Location	Year	# Nests Occupied	# Nests Inactive	# Nests Productive	% Nest Success	# of Fledglings	# of Fledglings/ Productive Nest	# of Fledglings/ Occupied Nest
Michigan	1970 12/	79	--	33	42	61	1.85	0.77
	1971 12/	74	--	41	55	79	1.93	1.07
Montana f/	1967 13/	16	17	8	50	17	2.13	1.06
	1968 13/	20	13	8	40	14	1.75	0.70
	1969 13/	20	16	9	45	15	1.67	0.75
	1970 13/	24	16	17	71	31	1.82	1.29
Oregon g/	1969 14/	68	--	25	37	35	1.40	0.51
Oregon h/	1970 15/	43	--	20	46	39	1.95	0.91
	1971 15/	52	--	31	60	60	1.94	1.15
	1973 16/	77	42	59	77	115	1.95	1.49
Oregon i/	1972 16/	69	25	42	61	68	1.62	0.98
Wyoming j/	1972 17/	26	--	13	50	19	1.46	0.73
	1973 17/	33	--	18	55	29	1.61	0.88

a/ Lassen National Forest
b/ Lassen, Plumas Counties
c/ NW California, including major streams, Humboldt Bay, Usal Creek
d/ Florida Bay
e/ Includes eastern Washington in 1972 and 1973
f/ Flathead Lake
g/ Crane Prairie Reservoir
h/ Deschutes National Forest
i/ Bend District, Deschutes NF
j/ Yellowstone National Park

1/ Kahl 1971
2/ Garber 1972
3/ French 1972
4/ Ogden 1969
5/ Schroeder 1972
6/ Johnson and Melquist 1973
7/ Melquist 1974
8/ Reese 1970a
9/ Reese 1970b
10/ Reese 1971

11/ Postupalsky in Hickey 1969
12/ Postupalsky in Garber 1972
13/ D. L. MacCarter 1972, Koplin et al. in Garber 1972
14/ Roberts 1970
15/ Lind 1972
16/ E. A. Nichols, personal communication
17/ Swenson and Eng 1973

Productive nest (successful nest): an occupied nest from which at least one young fledged during the season under consideration, or, if actual fledging cannot be proved, an occupied nest in which at least one young was raised to an advanced stage of development (i.e., to near fledging age).

Nest success: The percentage of occupied territories (for which the outcome of nesting efforts is known) which produce at least one young.

While material in Table I has been generally modified to conform to Postupalsky's definitions, several researchers have more recently come to disagree with his definition of an "occupied nest," placing it in the same category with "active nest." This disagreement stems from the attendance of nests by pairs of ospreys which subsequently produce no eggs or young. Postupalsky believed that since non-breeding pairs defend a territory, they may prevent potential breeders from utilizing that nesting site, lowering productivity where nest sites are in limited supply. Hence, he views non-breeding as a type of nesting failure. But Henny and Van Velzen (1972) point out that between five and ten percent of ospreys on northern breeding grounds are immature two-year-olds, which cannot technically be viewed as part of the breeding population even though they may attend nests during portions of the breeding season. Henny and Van Velzen feel that only if nests with no eggs are excluded from productivity studies can the observed recruitment rates be properly compared with the recruitment standard calculated by Henny and Wight (1969). In northern Idaho, where nest site availability does not appear to be a limiting factor, the inclusion of nest sites attended by non-breeding pairs disguises the true number of nesting attempts, inflating the figure. Johnson and Melquist also prefer to list as "active" only those nests in which ospreys lay eggs (Johnson, personal communication; Melquist, 1974).

Habitat Requirements and Limiting Factors

The osprey requires suitable nesting sites available near an abundant food supply. All habitats where colonies of nesting ospreys occur, such as Lassen National Forest, California, Crane Prairie Reservoir, Oregon, Flathead Lake, Montana, the lower St. Joe River and the mouth of the Clark Fork River, Idaho, meet these requirements (Garber, 1972; Johnson and Melquist, 1973; Kahl, 1972; D. L. MacCarter, 1972; Roberts, 1969).

Since ospreys feed almost exclusively on fish, they usually nest near streams or bodies of water having an abundant supply of fish for food. Areas with an abundance of suitable nesting

sites but supporting only impoverished fish faunas exhibit lower osprey densities than do locations with adequate supplies of both food and nest sites (French, 1972).

The ideal osprey nest site occurs on a dead snag standing either in or near a body of water, having a broken top or side limbs able to support the nest, and tall enough to provide both security and good visibility (Johnson and Melquist, 1973; Kahl, 1971; Koplin, 1971; Roberts, 1969). In northwest California, 54 percent of 67 nest sites along major streams occurred within 90 m of the stream and 24 percent were between 90 and 350 m of the stream. All but one of the remaining nests occurred within one-half mile of a stream. At Eagle Lake and other reservoirs in Lassen and Plumas Counties, California, ospreys built 55 percent of 60 nests within one km of a body of water and constructed the remainder within ten km of lakes or reservoirs. Ospreys built 29 nests in dead snags, 29 in live trees, and two on artificial structures. Nests averaged 25 m above the ground (Garber, 1972). Ospreys at Crane Prairie Reservoir used primarily ponderosa pine (Pinus ponderosa) and lodgepole pine (Pinus contorta) snags surrounded by water or near the shoreline, but sometimes utilized living ponderosa pine up to 1.6 km from the reservoir. Lodgepole pine snags averaged 6-21 m, ponderosa pine snags, 12-30 m, and living ponderosa pine, 27-33 m in height (Roberts, 1969). In northern Idaho, Schroeder and Johnson surveyed 166 nesting sites in 1971 and found that 36 percent were located in snags, 26 percent in live conifers (mostly grand fir, Abies grandis), 23 percent in black cottonwoods (Populus trichocarpa), 10 percent on pilings, four percent on power poles and one percent on bridges. Even-age second growth forests provide fewer nesting sites than does old-growth timber with interspersed snags and trees with broken tops (Johnson and Melquist, 1973). Flathead Lake ospreys placed their nests in the tops of both living and dead ponderosa pine from 7.5 to 140 m above the ground (D. L. MacCarter, 1972).

In addition, ospreys prefer to build their nests near accessory perches. Ospreys will utilize almost any elevated structure as a perch, provided it remains within sight of the nest, for sunning and protection from wind. On the Lassen National Forest, accessory perches averaged 19 m in height and 89 m in distance from the nest (Garber, 1972; Kahl, 1972).

Many factors serve to limit osprey numbers and productivity. Some are important only locally, while others exert at least some pressure on virtually every sizeable osprey breeding population.

The quantitative effects of predation on osprey eggs and young remains unknown. Generally, predation is minimal due to the

attentiveness of adult ospreys to their nest, but some predation by racoons, great blue herons, magpies, gulls, and ravens may occur locally (Roberts, 1969; Kahl, 1971; French, 1972; D. L. MacCarter, 1972).

High winds destroy nests and blow down nesting snags throughout the year and may cause substantial losses of eggs and young during the nesting season (Kahl, 1971, 1972; French, 1972; Garber, 1970, 1972; Johnson and Melquist, 1973; Koplin et al., 1971; D. L. MacCarter, 1972). Wind is one of the factors which seems to restrict nesting ospreys in northern coastal California (French, 1972). Lightning has also destroyed osprey nests and young (Johnson and Melquist, 1973; Kahl, 1971).

Nesting site losses occur for several reasons. At Eagle Lake, California, many suitable nest snags were created when the shoreline was flooded in the early 1900's. Now all nesting snags in the area are severely deteriorated and most will fall in the next decade. Many ospreys presently utilize only marginal nesting sites. The decline in suitable nesting sites may have contributed to a decrease in osprey numbers since the 1920's and 1930's (Kahl, 1971). Logging operations which fell snags and large overstory trees, especially within two miles of fishing waters, destroy preferred osprey nesting habitat for one hundred years or more (Kahl, 1972). In northern Idaho, the proposed removal of pilings along the Pend Oreille River by the U. S. Army Corps of Engineers will destroy nest sites which six pairs of ospreys used in 1972. A proposal to widen the channel of the lower St. Joe River will further degrade nest site availability. Bank erosion has already caused some nest trees to fall in this area (Johnson and Melquist, 1973).

The influence of food supplies upon osprey productivity has been investigated in California and Montana. D. S. MacCarter (1972) concluded that food resources did not limit osprey productivity at oligotrophic Flathead Lake, Montana, and Garber (1972) reached the same conclusion for mesotrophic Eagle Lake and oligotrophic Lake Almanor, California. But comparison of the data from all three areas yields some interesting information. First, the overall fledgling productivity averaged higher at the mesotrophic lake than at the two oligotrophic lakes. Second, while only 11 and 9 percent of the breeding pairs of ospreys at Flathead Lake and Lake Almanor, respectively, fledged three or four young, 19 percent of the ospreys at Eagle Lake did so. Third, partially eaten or uneaten prey remains occurred beneath osprey nests at mesotrophic Eagle Lake while none occurred beneath nests at the two oligotrophic lakes. The fact that ospreys supplied more food to broods of three or four at the mesotrophic lake than they did at the two oligotrophic lakes further indicates better food conditions at Eagle Lake. Fourth, although

ospreys at Flathead Lake experienced a slightly greater fishing success than those at Eagle Lake, they spent almost twice as much time foraging, indicating that ospreys at both lakes were equally capable hunters but had more difficulty locating food in the oligotrophic lake than in the mesotrophic lake. On the basis of these comparisons, Koplin, D. S. MacCarter, Garber, and D. L. MacCarter (1972) concluded that differences in available food resources did indeed influence fledgling productivity in these three osprey populations, and may have been responsible for differences up to 0.20 fledglings per nesting pair of ospreys, the difference in productivity between Eagle Lake and Flathead Lake. Food resources did not seem to limit productivity in ospreys breeding in established nesting territories along streams in northwest California, but available food resources probably served to limit the abundance and distribution of nesting territories along streams in this area (French, 1972). The majority of nesting ospreys in northwest California occur near coastal bays or lagoons, or on streams draining agricultural areas. Streams draining forested lands support fewer ospreys, probably as a result of impoverished fish faunas due to poorer nutrient enrichment (Koplin, 1971).

Osprey food habits may conflict with certain fishery management practices. Tui chubs comprise 87 percent of the fish fauna at Crane Prairie Reservoir, Oregon, competing directly with trout and kokanee for food and space. Management of the reservoir for a cold water fishery would require reducing the numbers of tui chubs, but the chubs form the majority of prey items for ospreys nesting there. Since Crane Prairie Reservoir is presently under management by the U. S. Forest Service primarily for the protection of the osprey nesting colony, the problem is not as serious as it might be elsewhere (Roberts, 1969, 1970).

Ospreys may successfully rear young in close proximity to humans. They have nested near homes and summer cottages (Bent, 1937) and even on highway median strips (French, 1972; Johnson and Melquist, 1973). The friendly attitudes of some homeowners may even benefit ospreys by protecting them from human harassment (Bent, 1937; D. L. MacCarter, Koplin and D. S. MacCarter, 1969). However, many forms of human activity are deleterious to ospreys and generally take one of three forms: direct mortality, loss of eggs through disturbance of incubating birds, and forcing fledglings from the nest before they attain full flight stage (Kahl, 1972).

Shooting is the major cause of osprey mortality in northern Idaho. Shooting losses are usually localized and heavy, especially in areas near human populations which are not under some form of surveillance (Johnson and Melquist, 1973). Deliberate and accidental shooting also threatens ospreys at Crane

Prairie Reservoir (Roberts, 1969, 1970). Relative isolation of nests and the presence of property owners decrease the importance of shooting as a mortality factor at Flathead Lake and in northwest California (D. L. MacCarter, et al., 1969; French, 1972).

Campers, fishermen, loggers and even bird watchers who carry out their activities too close to incubating or brooding ospreys may cause losses of eggs or young by keeping the parent birds off the nest. In some cases uninformed individuals, by approaching nests too closely, frighten juvenile birds from the nest before they are ready to leave. These young birds can fly only short distances and may be unable to return to the nest (French, 1972; Garber, 1972; Kahl, 1972; D. L. MacCarter, et al., 1969). The removal of eggs from osprey nests and other forms of intentional human harassment has obvious effects on productivity (Johnson and Melquist, 1973; Kahl, 1971).

Chemical contamination, especially by organochlorine pesticides (DDT, heptachlor, dieldrin, endrin, chlordane) and their metabolites, has affected osprey populations in many parts of the world. Beginning in 1947, when DDT came into wide agricultural use, several species of high trophic level raptorial and fish-eating birds including peregrine falcons (Falco peregrinus), bald eagles, Cooper's hawks (Accipiter cooperi), and ospreys, began to experience severe population declines due to reproductive failure. Symptoms of this unprecedented phenomenon, similar in all species, included: delayed breeding or complete failure to lay eggs, thinning of eggshells and associated egg breakage, failure to produce a second clutch of eggs upon loss of the first, aberrant reproductive behavior, and a high embryonic and fledgling mortality (Peakall, 1970). Hickey and Anderson (1968)compared declining populations of bald eagles, peregrines, and ospreys with stable populations of other raptorial species. Eggs collected from declining populations since the late 1940's showed an average decrease in shell thickness of at least 19 percent over those from stable populations. Investigators have demonstrated a correlation between body levels of chlorinated hydrocarbons and degree of eggshell thinning for several species of birds (Peakall, 1967, 1970; Porter and Weimeyer, 1969; Heath, Spann, and Kreitzer, 1969; Hickey, 1969; Hickey and Anderson, 1968; Enderson and Berger, 1968, 1970).

Chlorinated hydrocarbons affect avian reproduction in at least two ways. First, they induce liver cells to produce microsomal enzymes which degrade the sex hormones testosterone, progesterone, and estrogen by hydroxylation, reducing their body concentrations below levels necessary for normal reproductive behavior. Delayed breeding, failure to lay eggs, failure to produce second

clutches, and egg-eating behavior by parent birds result. Second, chlorinated hydrocarbons inhibit the activity of carbonic anhydrase, an enzyme necessary for the mobilization of carbonate ions essential to normal eggshell production. This causes eggshell thinning which leads to egg breakage or dehydration of the embryo. While different species of birds vary widely in their response to organochlorine contamination, Peakall (1967) demonstrated that relatively small amounts of DDT or dieldrin can cause increased rates of steroid metabolism by hepatic enzyme induction (Peakall, 1967, 1970). Ingestion of only a few highly contaminated prey items radically altered dieldrin levels in prairie falcons (Falco mexicanus). Food supplies varying in pesticide content may explain variations in levels of residues acquired by wild birds (Enderson and Berger, 1970).

Pesticides may be responsible for most of the reproductive inhibition exhibited by osprey populations in the western United States (Koplin, 1971). At Eagle Lake, California, cracked and crushed eggs accounted for an average of 23 percent of osprey mortality between the egg and fledgling stages. Concentrations of DDT and its metabolites reaching 17.9 ppm (lipid-weight basis) occurred in Eagle Lake osprey tissues; concentrations in various prey items attained 0.355 ppm. The Eagle Lake study substantiated a correlation of high organochlorine pesticide levels and incidence of egg breakage. When DDT residues in eggs dropped to 5 ppm in 1971 from a 1970 level of 12 ppm, the incidence of eggshell breakage declined from 31 percent to 16 percent. The failure of eggs to hatch increased from 13 percent of 15 nesting efforts in 1970 to 15 percent in 1971. Three of five unhatched eggs collected for study had been developing normally when embryonic death took place. The number of osprey pairs successful in hatching young declined from 56 percent in 1969 to 52 percent in 1970 (Garber, 1972; Kahl, 1971, 1972).

At Flathead Lake, Montana, lake trout, a species occupying a high trophic level, contained the highest levels of DDT residues of all fish species analyzed. Pesticide residues appeared in the osprey's major prey species, the largescale sucker, in the following concentrations: 0.16 ppm, DDT; 0.37 ppm, DDE; 0.09 ppm, DDD (D. S. MacCarter, 1972). DDT residues in Flathead Lake osprey eggs averaged much higher. In 1968, four addled eggs showed DDT residues averaging 42.5 (range 25.0 - 59.1) ppm on a dry-weight basis. Analysis of 11 eggs collected in 1969 and 1970 revealed concentrations averaging 34.7 (range 10.4 - 135.2) ppm on a wet-weight basis. Twenty addled eggs taken from osprey nests all contained well-developed, but dead embryos. Embryonic death might have resulted from egg chilling due to the prolonged absence of incubating parents from the nest. But since Flathead Lake receives little human use, and hence little human disturbance, until after the incubation period, it seems

unlikely that disturbance factors would cause so many ospreys to vacate their nests. Pesticide residues in the eggs remain as the only probable factor accounting for the high rate of embryonic mortality. In addition, three of the unhatched eggs showed eggshell cracking and flaking, further suggesting the role of pesticide contamination in reproductive failure (D. L. MacCarter, 1972).

Despite some indications of stability in western populations and the declining use of persistent pesticides in the United States, ospreys still face a threat from organochlorine pesticides on their wintering grounds. The use of DDT and other organochlorine pesticides remains high in Central and South America. To determine the full effects of persistent pesticides on western osprey populations, long-term studies are needed (Johnson and Melquist, 1973).

Polychlorinated biphenyls (PCBs) bear a molecular resemblance to DDT and exert similar physiological effects. Although they do not cause the degree of eggshell thinning characteristic of DDT and its metabolites, PCBs are much more effective in reducing estrogen levels through hepatic enzyme induction. As a result birds contaminated with PCBs have experienced delayed breeding. Large birds, having longer incubation periods and slower juvenile development, may be unable to raise their young to maturity if they experience artificial delays in the onset of breeding. PCBs are plasticizers having wide industrial and commercial use, and become dispersed in the atmosphere when plastics containing them are incinerated. Presently the highest atmospheric PCB levels occur in industrial areas, but investigators have detected low concentrations in widely diverse environments (Peakall, 1970; Risebrough, Rieche, Herman, Peakall, and Kirven, 1968).

Heavy metal contamination may also threaten ospreys. Sediments in the Coeur d'Alene River, Idaho, contain high levels of zinc, lead, iron, and copper due to long-term mining activity in the river basin, but their effects on ospreys remain unknown (Johnson and Melquist, 1973). Peakall and Lovett (1972) have reviewed some effects of mercury on certain avian species. Wild birds showing symptoms of mercury poisoning have had concentrations of mercury in the liver of as little as 15 ppm, while pheasants (Phasianus colchicus) fed on seed containing 20 ppm of mercury accumulated concentrations of 30 - 130 ppm in their livers. Although differences in field and laboratory conditions may have been related to other factors, some evidence indicates that normal stresses in the wild produce death at lower toxicant levels than would occur under laboratory conditions (Stickel, 1968). In addition, considerable amounts of mercury present in

female birds are transferred to eggs (Tejning, 1967). Mercury residues have appeared in tissues of dead ospreys found at Crane Prairie Reservoir, Oregon (Koplin, 1971).

Protective Measures Instituted

A. Legal or Regulatory

1. Regulations limiting the registration of DDT and other persistent pesticides in the United States may be helpful in reducing pesticide burdens in populations of ospreys breeding in this country.

2. On March 10, 1972, the osprey was added to the list of bird species protected by the Convention between the United States of America and the United Mexican States for the Protection of Migratory Birds and Game Mammals, originally ratified on February 7, 1918.

B. Habitat Protection and Improvement

1. The U. S. Forest Service has established two Osprey Management Areas. The 4240 hectare Crane Prairie Reservoir Osprey Management Area, on the Deschutes National Forest, Oregon, consists of a maximum of 1540 hectares of water and 2700 hectares of timber in the surrounding buffer strip. The Crane Prairie Reservoir Osprey Management Area has as its primary management objectives the protection and improvement of osprey habitat, protection of the osprey, and provision of opportunities for public enjoyment. Secondarily, the Management Area exists to protect other potentially endangered wildlife such as the bald eagle and to improve and protect habitat. The natural resources of this area are managed by the U. S. Forest Service, the Bureau of Reclamation, and the Oregon State Game Commission (Roberts, 1969).

   In the fall of 1971 the Lassen National Forest formed an Osprey Management Area of about 480 hectares along the west shore of Eagle Lake as part of the Eagle Lake District's Multiple Use Plan. The Lassen National Forest Osprey Management Plan (Kahl, 1971) states as its primary purposes (1) identification of suitable osprey habitat on the Lassen National Forest; (2) provision of guidelines for implementing a continuous habitat protection and improvement plan; (3) determination of major habitat problems, and (4) establishment of a management area to protect the osprey and its habitat. Secondarily the Management Plan provides for assembling

and disseminating information on the osprey and its habitat to Forest Service and other personnel to increase interest in the osprey. Since the area was designated an Osprey Management Area the number of nesting ospreys using it has increased 23 percent and the number of young produced has increased 20 percent (Phil Smith, Range and Wildlife Officer, Lassen National Forest, personal communication). Responsibility for habitat protection and improvement rests with the U. S. Forest Service, while the California Department of Fish and Game has responsibility for protection of the osprey (Kahl, 1971).

Species and Habitat Management Recommendations

Both the Lassen National Forest and the Deschutes National Forest have published osprey habitat management plans for their respective Osprey Management Areas. Some management programs and techniques specifically applicable to these areas have not been included in this section of the report. But presented here are references to the management plans, and addresses of the National Forest Headquarters, for those who have a genuine need for additional management information:

Kahl, J. R. 1971. Osprey habitat management plan, Lassen National Forest. 38 p. (mimeo.). U. S. Forest Service, Lassen National Forest, 707 Nevada Street, Susanville, California 96130.

Roberts, H. B. 1969. Osprey management area plan, Crane Prairie Reservoir, Deschutes National Forest. U. S. Forest Service/Oregon State Game Commission. 20 p. U. S. Forest Service, Deschutes National Forest, 211 E. Revere Ave., Bend, Oregon 97701.

A. Research Needs

1. Extensive banding data are needed to calculate mortality schedules for western osprey populations and to determine the degree of exposure to pesticides facing these birds on their wintering grounds. Only continued research can fully determine the status of western osprey populations and the relative importance of limiting and mortality factors in regulating osprey numbers and productivity (Garber, 1972).

2. Federal agencies should continue to conduct and/or support osprey research in the West.

3. Successful management presupposes an accurate census of nesting populations and a determination of their productivity. For ospreys, at least two surveys are necessary: the first in early May to determine the location and number of nesting pairs and another in mid-July to determine the number of young produced. If only one survey is possible, that in mid-July will provide the data most useful for management purposes. (See Addendum for further discussion of survey methods.)

These surveys require patience to assure accuracy. This is particularly true in attempting to count nestlings in a high snag nest. A close approach causes the female to flush, circle, and give the "down call" at which the young crouch. One can best observe nests at a safe distance with a spotting scope. Even then the smallest nestling may not be visible since it is not as active as its older siblings. Since the smallest osprey may not become visible over the rim of the nest for as long as 20 minutes (rarely to one hour), surveillance of nests should be carried out for at least this length of time. Obviously multiple visits improve the accuracy of the count (Johnson and Melquist, 1973). Nesting surveys should be conducted annually.

B. Habitat Protection

Where ospreys persist in colonial situations, the two primary habitat factors, nesting sites and fish supply, occur in adequate quantities. A reduction in either would lower osprey numbers (Kahl, 1971).

In areas offering suitable habitat for ospreys, the clearing of snags or live trees suitable for nesting, perching, and roosting should not be undertaken within one-half mile of osprey feeding waters. Snags with broken tops and live trees at least 15 m tall make good nest trees (Kahl, 1971). At Crane Prairie Reservoir and Eagle Lake Osprey Management Areas, where ospreys nest mainly along shorelines, the Deschutes and Lassen National Forests have adopted timber management guidelines to maintain osprey habitat at its highest level consistent with other resource values and uses. The following guidelines can apply as well to places where similar situations exist:

1. Cut no timber or snags within approximately 70 m of water bodies where ospreys nest, except for individual trees hazardous to roadway or campground activities.

2. Beyond the 70 m "no-cut" zone, establish an additional 400 m "restricted-cutting" zone, reserving a minimum of two dominant live trees and two desirable snags per acre for osprey nesting.

3. Preserve all broken-top snags and live trees suitable for osprey nesting for a distance of approximately 3.5 km beyond the 400 m zone.

4. Preserve three to five trees suitable for nesting or roosting within approximately 220 m of all osprey nest sites (Garber, Koplin, and Kahl, 1974; Kahl, 1971; Roberts, 1970).

To protect potential nest sites and other nest trees from cutting by uninformed individuals and to protect nesting ospreys, the Lassen National Forest places metal signs on nest trees bearing this message: "Osprey nest tree. The osprey, or fish hawk, is a threatened species (sic) in the United States. This tree supports an active nest and must not be cut or used for other purposes. Human activity is not permitted within one-eighth mile (0.2 km) of the nest from April 1 to August 31. The osprey is protected by law--do not shoot!" (Kahl, 1972).

If rough fish compete with game fish in waters where ospreys forage, the management of such a body of water for sport fishing may directly conflict with the food requirements of the ospreys. Before initiating any fish control projects in waters used by ospreys, conduct thorough research in advance of such control to determine its effect on the ospreys. Give the ospreys full consideration if such control is needed (Roberts, 1969, 1970; Kahl, 1971).

C. Habitat Improvement

Since ospreys utilize nest sites repeatedly, direct initial improvement efforts toward the maintenance of osprey nest sites. Where nesting snags are in a deteriorated condition they might be supported by guy lines or other bracing methods to prolong their usefulness. Large standing snags or living trees, suitably located but having tops unable to support osprey nests, may be improved by cutting off tops above a whorl of limbs able to support a nest, providing nest supports, or by placing platforms on the snags (Garber et al., 1974; Kahl, 1971; Roberts, 1969).

Ospreys readily nest on artificial structures. Areas having adequate fish supplies but lacking nesting sites, or where present nesting snags are falling, might benefit through the construction of artificial nesting platforms. Artificial nesting platforms should offer an elevated, unrestricted view and access to a food supply. Platforms intended to replace a deteriorated nest snag should be placed reasonably close to the snag. Determine the optimum size and location of nesting platforms through experimentation and analysis of active nest sites within the area (Kahl, 1971, 1972; Johnson and Melquist, 1973; Roberts, 1969, 1970).

Girdling or poisoning suitable live trees and removing the tops can also increase nest site availability. However, indiscriminate girdling produces poor results since ospreys are more likely to respond to nest sites in areas which have previously attracted birds. Girdling trees near former nest sites produces greater success (Johnson and Melquist, 1973; Kahl, 1971; Roberts, 1969). Removing tops from suitable living trees also increases their attractiveness to ospreys (Kahl, 1972).

D. Human Disturbance

Human activity can significantly influence productivity, especially in colonial nesting areas where disturbance could adversely affect many breeding pairs of ospreys simultaneously. Implement the following protective measures wherever possible:

1. Permit no human activity within 200 m of any active osprey nest, and restrict all vehicular traffic to roads not having portions lying within 200 m of any active nest, from April 1 to September 15 (Kahl, 1971; Roberts, 1970).

2. Close nesting areas to hunting or shooting between 1 April and 30 September. Hunting may be permitted after September 30, as most ospreys have migrated by then (Kahl, 1971; Roberts, 1969).

3. Prohibit tree or snag cutting by private individuals (Kahl, 1971, 1972).

4. Permit no overnight camping in or near osprey nesting areas from 1 April to 15 September (Kahl, 1972).

5. Construct no developments excepting osprey habitat improvements. Walking trails and public observation points for viewing ospreys should be placed so as not to disturb the birds or their activities (Kahl, 1971).

6. Enforce all regulations protecting ospreys.

E. Pesticide Contamination

Because of their deleterious effects on osprey reproductive success, no organochlorine pesticides should be used in osprey fishing waters, or in any watershed upstream from such waters. Before implementing any chemical control procedure, fully ascertain its effect on osprey reproductive success and food supplies (Johnson and Melquist, 1973; Roberts, 1970).

F. Public Awareness

An adequate information and education campaign can do much to protect the osprey from human disturbance. The following methods can increase public understanding of, and sympathy for, the osprey's role in its ecosystem:

1. Wildlife biologists can conduct show-me trips for certain key individuals and groups to acquaint people with the osprey and its problems. Trips should be conducted in late July when young are visible on the nest (Kahl, 1971; Roberts, 1970).

2. Post interpretive signs near places where ospreys nest or fish, especially if human use of the area is heavy. Signs should explain basic osprey life history, and concern for its precarious status as a potentially endangered species (Roberts, 1969, 1970; Johnson and Melquist, 1973).

3. Agencies administering osprey habitat might develop slide-tape programs on local ospreys, provide periodic releases to news media and scientific journals, and publish short handout pamphlets for distribution to the public in osprey areas (Kahl, 1971).

Current Research in the Western United States

1. Dr. Donald R. Johnson and Wayne E. Melquist, Department of Biological Sciences, University of Idaho, Moscow, Idaho 83843, are monitoring the effects of pesticide contamination on the reproductive success of ospreys in northern Idaho and eastern Washington. This fall Johnson will begin a study of the migration and postfledging behavior of immature ospreys in the same area.

2. Jon E. Swenson, Department of Biology, Montana State University, Bozeman, Montana 59715, is studying human-osprey relationships in Yellowstone National Park. He has studied the Yellowstone osprey population for two summers to determine the effects of human disturbance on osprey reproductive success. To test the data he has gathered so far, the National Park Service will close backcountry campsites near osprey nests this summer. The results of this study should provide information very useful to land managers dealing with osprey populations in areas sustaining human use. Swenson's M. S. thesis should be available from Montana State University about January, 1975.

3. Howard Levenson, School of Natural Resources, Humboldt State University, Arcata, California 95521, has recently initiated Master's degree research on the behavior and energetics of nesting ospreys, to fully describe the breeding behavior and compile a time and activity budget for nesting ospreys. He is also performing feeding experiments with falconiforms, and will use data on existence metabolism for other falconiforms to predict the existence metabolism for ospreys. By combining all this information he hopes to present a fairly accurate quantitative analysis of the energetics of osprey reproduction.

Summary

The osprey is the sole member of the family Pandionidae, owing to the unique morphological adaptations which enable it to hunt fish successfully. Ospreys, medium-large hawks attaining body lengths of 53 to 65 cm, possess distinctive plumage and behavioral traits which distinguish them from all other raptorial birds.

While several subspecies occur over the earth, only one, Pandion haliaetus carolinensis, lives in North America. This subspecies breeds in suitable localities across the continent from northwestern Alaska and northern Canada south to Baja California and east along the Gulf of Mexico to Florida and the Atlantic seaboard. Large western breeding populations occur inland in California, Oregon, Idaho, Montana, and Wyoming.

Ospreys winter primarily in Central America, though a few individuals reach Chile, Argentina, Paraguay and the Galapagos. Non-breeders may spend all year on their winter range.

While North American osprey populations had been gradually declining in numbers since the late nineteenth century, this trend accelerated drastically in the 1950's when breeding populations throughout the United States crashed, owing to reproductive failure. While this trend was more pronounced in the eastern United States, western osprey populations have not been unaffected. Fewer banding data exist for western ospreys, and while long-term trends remain unknown, certain of these populations may be declining at rates of from two to five percent annually.

Ospreys occasionally consume mammals, birds, reptiles, amphibians and invertebrates, but they depend almost exclusively on fish for food. Moreover, they tend to concentrate on only a small percentage of the fish fauna present in any given locality, utilizing only two or three species regardless of the number of species present.

The osprey hunts by flying over the water at heights ranging from 15 to 30 meters. When it spots a fish it hovers momentarily, then stoops to its intended prey, entering the water feet first with its wings extended above and behind its body, grasping the fish in its talons. It leaves the water and returns to a perch to consume its meal.

Ospreys are highly efficient predators, capable of capturing two fish in a single dive, and may demonstrate overall predatory success rates of 80 to 90 percent. Abundance of prey, individual experience, surface water temperature, tidal changes, visibility, and food demands by young ospreys influence both the rate of predatory success and the time expended in every successful fishing effort.

Adult ospreys begin to arrive on their nesting grounds from mid-March to early April. Pair bonding and nest site selection may carry over from year to year in certain individuals and populations. Courtship consists of a spectacular series of dives and displays followed by copulation at or near the nest.

Ospreys often use the same nest repeatedly. They spend most of April repairing the nest or constructing a new one. They prefer to build their nests in the tops of dead snags but will also utilize live trees with dead crowns and various artificial structures.

The female lays a clutch of three or four eggs in late April or early May. Her mate shares up to 30 percent of the incubation, but helps with neither incubation nor brooding after the first egg hatches. Incubation takes from 38 to 43 days in the western United States. The male feeds the female, who rarely leaves the nest during incubation and the first six weeks of the eight-week brooding period. The young hatch from late May to mid-June. Ospreys which experience reproductive failure may construct a "frustration nest" after abandoning their unhatched eggs.

Male ospreys furnish all food to the nest for the first six weeks after hatching, when they are assisted by the females. For the first thirty days the female broods the young constantly. After this her brooding behavior depends on weather, nest location and age of nestlings.

If an intruder threatens the nest, adult ospreys sound a warning call which causes the young to lie prostrate on the floor of the nest for periods up to one hour, until a parent bird sounds a note of assurance. The adults meanwhile scream loudly, circle the intruder, and may attack.

Young ospreys make their first flight when about eight weeks old. Fledging begins in the third week of July and extends into August. For the next two months immature ospreys continue to associate with their nest and parents, using the nest for roosting and feeding.

Migration begins in mid- to late September and continues through October. Ospreys move slowly toward their wintering grounds and arrive there in December. Two-year-old birds either remain on the wintering grounds through the summer or return to nesting areas and defend territories, although they do not breed until the age of three years.

Bald eagles and magnificent frigate birds occasionally steal fish from ospreys, but they are seldom successful and seem to do no harm to the ospreys. Ospreys tolerate most other species until the onset of incubation when they display increased aggression to larger birds near their nests. Canada geese may compete with ospreys in some areas for nest sites.

Calculations based on banding returns from an eastern osprey population showed that every breeding-age female would have to produce at least 1.22 fledglings per year to offset mortality and maintain population stability. While most western populations do not achieve this rate of production, they may not be experiencing mortality rates equal to those of their eastern counterparts. While osprey numbers appear to be stable or increasing in some western areas, they still experience severe reproductive inhibition. Any trends seeming to indicate stability in western osprey populations should be accepted most cautiously.

The osprey requires an availability of suitable nesting sites near an abundant food supply. Ospreys usually nest near streams or lakes having plentiful supplies of fish for food. Dead snags surrounded by or near a body of water, having broken tops or side limbs able to support nests, and tall enough to provide both visibility and security make ideal osprey nest sites. Ospreys also prefer accessory perches, for sunning and protection from wind, within sight of their nest.

Several factors potentially limiting to osprey numbers and productivity include predation, weather, nest site losses, food supply, fishery management practices, human disturbance, and chemical contamination. In most cases the effects of predation, weather, food supply, and fishery management practices are important only locally, if at all.

Nest site losses occur either naturally in conjunction with some factor such as weather, or as a result of human activity, notably timber management. Trees which ospreys prefer for nesting are

often viewed as fire or safety hazards, or simply as undesirable, from a timber management viewpoint. Human disturbance partly results from ignorance. Recreation activities near nests by uninformed individuals or groups may cause ospreys to abandon eggs or young. Deliberate harassment by even a few unscrupulous persons can cause locally heavy losses through shooting, disturbing nests or egg collecting. Young birds forced from the nest before they are ready to fly may be unable to return.

Chemical contamination may be the most important limiting factor operating in western osprey populations. Organochlorine pesticides cause eggshell thinning and breaking, delayed breeding, failure to lay eggs, aberrant reproductive behavior, and high embryonic and fledgling mortality. Organochlorine residues appear in osprey tissues and in those of their prey in most western populations. Although their effects on ospreys have not been fully assessed, polychlorinated biphenyls and heavy metals may also pose threats in the future.

Addendum

As this report was going to press, the following paper appeared:

Henny, C. J., M. M. Smith and V. D. Stotts. 1974. The 1973 distribution and abundance of breeding ospreys in the Chesapeake Bay. Chesapeake Science 15(3):125-133.

The authors estimate that 1450 ± 30 pairs of ospreys (including two to five percent nonbreeders) nested on Chesapeake Bay in 1973. They combined an aerial survey with intensive ground and boat surveys and recommend this method as being more accurate than either aerial surveys or ground surveys used alone.

Interestingly, the distribution of breeding ospreys on Chesapeake Bay has changed in the last several decades due to the increasing number of artificial structures (buoys, channel markers, offshore duck blinds and nesting platforms) available to nesting ospreys. In 1973, 31.7 percent of ospreys nested in trees, while 17.8 nested on artificial platforms and miscellaneous man-made structures. Over half of the nesting birds utilized offshore duck blinds (28.7 percent) and channel markers (21.8 percent). Furthermore, information from the survey indicated that tree nests were less successful than offshore nests on artificial structures. A higher recruitment rate would be a definite advantage for the selection of stable offshore nest structures resistant to predation by terrestrial animals. Reese (1969) also suggested that offshore nest sites offer protection from land predators and, to some extent, humans. The authors suggest that future nesting studies attempt to determine the effect that different types of nesting structures might have on osprey nesting success.

Authorities

While I do not wish to minimize the importance of research which has been conducted on western osprey populations, I felt it impractical to list everyone who might qualify as an osprey authority simply because a list of all recent osprey investigators would be unwieldy. The two individuals listed below have supervised virtually all the academic research conducted on osprey populations in the western United States and are familiar with other osprey investigators and ongoing osprey research in the West:

Dr. Donald R. Johnson
Department of Biological Sciences
University of Idaho
Moscow, Idaho 83843

Dr. James R. Koplin
School of Natural Resources
Humboldt State University
Arcata, California 95521

Authorities on ospreys in other parts of the United States include:

Dr. Mitchell A. Byrd, Chairman
Department of Biology
College of William and Mary
Williamsburg, Virginia 23185

Dr. Thomas C. Dunstan
Department of Biological Sciences
Western Illinois University
Macomb, Illinois 61455

Charles J. Henny
U. S. Fish and Wildlife Service
Denver Wildlife Research Center
Building 16, Denver Federal Center
Denver, Colorado 80225

John Ogden
Everglades National Park
P. O. Box 279
Homestead, Florida 33030

Sergej Postupalsky
Department of Zoology
University of Wisconsin
Madison, Wisconsin 53706

Paul Spitzer
Laboratory of Ornithology
Cornell University
Ithaca, New York 14850

Governmental and Private Organizations Concerned with This Species' Welfare

1. National Audubon Society
   950 Third Avenue
   New York, New York 10022

   One major objective of the National Audubon Society is to advance public understanding of the value and need for conservation of our wildlife, its habitat and all natural resources and the relationship of wise use and intelligent treatment to human progress.

   National Audubon has a series of leaflets and charts on birds of prey and has concentrated its efforts for raptors in the area of education and protective legislation. In addition, the Society actively funds osprey research. This year it provided grants to D. R. Johnson for his study of migration and post-fledging behavior of northern Idaho ospreys, and to J. G. Reese for a study of the Chesapeake Bay osprey colony.

2. The U. S. Forest Service has established two Osprey Management Areas, discussed earlier in this report, where protection of ospreys and osprey habitat is of primary concern. Johnson and Melquist (1973) have proposed that the U. S. Forest Service support a third Osprey Management Area on the Clark Fork Delta, Idaho, on lands administered by the U. S. Army Corps of Engineers. The Forest Service presently has three publications (Johnson and Melquist, 1973; Kahl, 1971; Roberts, 1969) dealing with osprey management.

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